

DRIVE SYSTEM FOR ELECTRIC TOOTHBRUSHES AND THE LIKE

## BACKGROUND OF THE INVENTION

Various treating implements exist which include movable treating elements on the head portion of the implement. For example, power toothbrushes frequently have a brush head connected to the handle wherein at least a portion of the brush head rotates continuously in one direction or oscillates back and forth. Other treating implements which may have movable treating elements include, for example, electric razors, clippers, massage devices and various other personal grooming devices.

An example of a power operated toothbrush having an oscillating disk on its cleaning head is found in WO 03/02453. Such toothbrush includes a drive rocker coupled with a motor by a cam. The end of the drive rocker is fixedly mounted to the cam in a position eccentric to the motor shaft. As a result, when the motor shaft rotates the cam the drive rocker is moved in a funnel or cone-like manner. The drive rocker is mounted between the motor and the bristle support extending through a ring-shaped bearing element. By mounting the drive rocker between the motor and the bristle support with the bearing element, the drive rocker is fixed to a point so that the drive displacement of the drive rocker describes a double cone, wherein the peaks of the two converging cones lie in the area of the bearing element. The drive displacement of the drive rocker is transformed into the drive displacement of the bristle support.

It would be desirable to provide a drive system which imparts motions to a treating implement such as a power toothbrush wherein the motion is controlled in an effective, yet economical manner. It would also be desirable to provide such a drive system which could effectively operate using a small motor thereby having the treating implement be

inexpensive and of small size without detracting from its efficiency.

## SUMMARY OF INVENTION

An object of this invention is to provide a drive system for imparting motion to a treating implement such as a power toothbrush or the like so as to create and control the motion of the treating elements, such as the cleaning elements on the implement head.

A further object of this invention is to provide such a drive system which is effective in operation and yet economical in use and capable of being made in small size.

In accordance with this invention the drive system includes a cam rotatably driven around an axis of rotation by a motor. An outer surface of the cam has a closed loop cam track which is eccentric or offset to the axis of rotation. A control member is disposed between the cam and the treating implement head. The control member has a control slot extending completely through the control member with the slot being either symmetrical or being offset or non-symmetrical with respect to the axis of rotation of the motor. A pivot member is located between the control member and the treating implement head. A drive shaft has its drive end freely mounted in the cam track. The drive shaft extends through the control slot and through a hole in the pivot member with the driven end of the drive shaft mounted in a drive connection of the treating implement head. The drive shaft is located along an axis which differs from and is at an angle to the axis of rotation of the cam. During rotation of the cam, the drive shaft is confined in its path of motion by the control slot and cam track by permitting the drive shaft to travel freely in the cam track.

In a preferred practice of this invention the control slot is of straight linear shape extending radially with respect to the axis of rotation of the cam. The cam track is

preferably circular in shape so that there is a uniform speed during rotation of the drive shaft. Alternatively, if the cam track is non-circular, such as being oval or elliptical, the speed of the linear reciprocating motion of the drive shaft can vary.

The drive system could be used in connection with various types of treating  
5 implements. In a preferred practice of the invention one such treating implement is a power toothbrush wherein at least a portion of the toothbrush head, which carries cleaning elements such as bristles, is oscillated back and forth along an arc in response to the arcuate reciprocating motion of the drive shaft. In a preferred practice of the invention where the control slot is of straight linear shape, the control slot is also parallel to the  
10 cleaning element carrying surface of the brush head. As a result, a planar motion is achieved in oscillating the brush head.

In an alternative embodiment, the control slot can be perpendicular to the cleaning element carrying surface which would create vertical movement. In a further alternative the cam track could be elliptical, rather than circular.

## 15 THE DRAWINGS

Figure 1 is a front elevational view partly in section of a treating implement in the form of a power toothbrush in accordance with this invention;

Figure 2 is a side elevational view partly in section of the treating implement shown in Figure 1;

20 Figures 3-4 are cross-sectional views taken through Figure 1 along the lines 3-3 and 4-4, respectively;

Figure 5 is a cross-sectional view similar to Figure 3 in a different phase of operation;

Figure 6 is a cross-sectional view similar to Figure 4 in a different phase of operation;

Figure 7 is a schematic front elevational view showing one phase of operation of the drive system of this invention;

5        Figure 7A is a view similar to Figures 3-4 combined in accordance with the phase of operation shown in Figure 7;

Figure 8 is a view similar to Figure 7 in a different phase of operation;

Figure 8A is a view similar to Figure 7A in the phase of operation shown in Figure 8;

10       Figure 9 is a view similar to Figures 7-8 in a different phase of operation;

Figure 9A is a view similar to Figures 7A and 8A in the phase of operation shown in Figure 9;

Figure 10 is a view similar to Figures 7, 8 and 9 in a different phase of operation;

15       Figure 10A is a view similar to Figures 7A, 8A and 9A in the phase of operation shown in Figure 10;

Figure 11 is a view similar to Figure 3 of a modified control member in accordance with this invention; and

Figure 12 is a view similar to Figure 4 of a modified cam member in accordance with this invention.

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#### DETAILED DESCRIPTION

The present invention is directed to a drive system for imparting motion to a treating implement wherein a treating element(s) is movably mounted on the head of the implement. The invention may be practiced where the entire head is movable or  
25       where only a portion of the head is movable with that movable portion including at

least some treating elements of the treating instrument. Representative examples of such treating implements include power toothbrushes, electric razors, clippers, massage devices and other personal grooming implements. It is to be understood that such listing of examples is not intended to limit the scope or practice of this invention.

5 One preferred practice of this invention is as a drive system for a power toothbrush. Such practice of the invention is illustrated in the drawings.

As shown in Figures 1-2 a power toothbrush 10 include a hollow handle 12 and a brush head 14 connected to the handle by a hollow neck 16. In the illustrated form of the invention the brush head 14 includes a fixed section 18 and a movable disk 20.

10 Both fixed section 18 and disk 20 are provided with cleaning elements 21 extending outwardly from their outer surface 22. Such cleaning elements may take any suitable form such as bristles made of fibers of the like or elastomeric elements of any size or shape. Similarly, the disk 20 could be of any size or shape. For the sake of illustration disk 20 is shown as being of generally circular shape. Disk 20 is intended to be  
15 oscillated rotationally back and forth over a limited arc by the drive system generally indicated by the reference numeral 24.

The handle 12 of toothbrush 10 may be of generally known structure which includes a battery operated motor 26 having a motor shaft 28 which is rotated by the motor 26 when the toothbrush 10 is actuated in a known manner. The axis of rotation  
20 of shaft 28 is generally indicated by the reference numeral 30 in Figures 7-10.

In accordance with this invention the drive system 24 includes a cam 32 which is operatively connected to and rotated by motor shaft 28 in any suitable manner such as being mounted to the motor shaft 28 by the motor shaft extending into and being operatively connected to a collar 34 of the cam member. Cam may be of any suitable  
25 size and shape and preferably is in the form of a plate or disk which is relatively thin

and is of circular shape having a diameter slightly less than the inner diameter of the portion of handle 12 in which cam 32 is located as best shown in Figures 1-2.

As illustrated in Figures 4 and 6 cam 32 includes a closed loop cam track 36 in its outer surface for reasons which will be later described.

5 Drive system 24 also includes a control member 38 located in the handle or neck of toothbrush 10 between cam 32 and head 14. Control member 38 may be of any suitable size and shape and preferably is a thin plate or disk which is mounted against shoulder 40 in handle 12. Control member 38 is illustrated as being circular in shape and mounted close to cam 32. Control member 38 could be of different shape and  
10 located further from cam 32. As illustrated in Figures 1-3 and 5 a control slot 42 extends completely through control member 38. Although cam member 32 is mounted for rotation, control member 38 has a fixed non-movable member mounting. Control slot 42 is positioned to be in line with the path of movement of cam track 36 while cam 32 is rotating, as later described. Figures 4 and 6 show the extreme different  
15 locations 180° apart of cam member 32 during its rotation. As shown therein in a preferred practice of this invention cam track 36 does not extend beyond the axis of rotation 30 or cam member center point, although cam track 36 is moved or rotates around the axis of rotation. Similarly, as shown in Figure 3 and 5 control slot 42 preferably does not extend beyond the axis of rotation, but could extend beyond the  
20 axis of rotation.

As later described control slot 42 may have various shapes and orientations. In a preferred practice of the invention the control slot 42 is of straight linear shape which is radially located with respect to the axis of rotation. Such radial location may begin at the axis of rotation 30. The invention, however, could be practiced where the  
25 control slot 42 is not confined solely to one side of the axis of rotation but could

extend through and beyond the axis of rotation and could be symmetrical to the axis of rotation.

A further member of drive system 24 is a pivot member 44. Pivot member 44 is shown as being located in the neck 16 where the neck merges with head 14. Pivot member 44 could be of any size and shape such as a plate mounted at any suitable location or could be an inwardly extending shoulder. Pivot member 44 has a through hole 46 which is lined with a flexible bearing 48 similar to that described in U.S. Patent No. 4,149,291, all of the details of which are incorporated herein by reference thereto. When such flexible bearing is made of a suitable elastomeric material it functions as a gasket.

A further element of drive system 24 is a drive shaft 50. Drive shaft 50 has a drive end 52 freely mounted in cam track 36. Drive shaft 50 extends through control slot 42 and through pivot member 44 with its driven end 54 extending into a slot 56 in the side of disk 20. The arrangement of a driven end in a disk to rotate in an oscillating manner the disk is similar to that of U.S. Patent No. 5,625,914 and of WO 03/024353, all of the details of which are incorporated herein by reference. Preferably, the driven end 54 is of generally ball or spherical shape to minimize any slippage and provide a smooth operation as the driven end 54 reciprocates the disk 20 while driven end 54 is located in slot 56.

Figures 7-10A and also Figures 3-6 illustrate the manner of operation of drive system 24. Figures 7A-10A show the relationship between the control slot 42 and the cam track 36 with respect to drive shaft 50 by superimposing in phantom the control slot 42 against the cam member 32. Control slot is of a size only slightly larger than the diameter of shaft 50 so that shaft 50 snugly slides in slot 42.

Figures 7 and 7A illustrate the phase of operation where drive shaft 50 is located at

the extreme outer end of control slot 42 and near the outer edge of cam 32 by being located in the portion of cam track 36 located near the edge of cam 32. This may be considered to  $0^{\circ}$  and  $360^{\circ}$  position. When in this position the movable disk 20 has been rotated to an angle of  $15^{\circ}$  of its axis of rotation. As cam 32 rotates cam track 36 is also rotated. During this rotation shaft 50 is confined by control slot 42 to slide in the control slot and yet still remain with its drive end in cam track 36. During this sliding motion drive shaft 50 pivots through pivot member 44 which in turn causes its driven end 54 to rotate disk 20. Figures 7-10A show the different locations at different phases of operation. Figure 8 shows how the various members of drive system 24 have been moved when cam 32 has rotated  $90^{\circ}$  from the  $0^{\circ}$  or  $360^{\circ}$  position shown in Figure 7. Thus, as shown in Figures 8 and 8A this  $90^{\circ}$  rotation causes drive shaft 50 to pivot so that the disk 20 is now moved to a location which is  $7.04^{\circ}$  off-center. As is clear from a comparison of Figures 7A and 8A, although cam 32 is rotating, drive shaft 50 is moved in a linear or planar direction because of the shape of control slot 42 which confines the moving drive shaft so that it can only move in the same straight linear shape of control slot 42. In the position shown in Figure 8A drive shaft 50 has moved inwardly of control slot 42 as compared with its location shown in Figures 7 and 7A.

Figures 9 and 9A show the position of the various elements or members of drive system 24 when cam member 32 has been rotated  $180^{\circ}$  from that of Figure 7. In this position, cam track 36 has also rotated  $180^{\circ}$  from the position it had in the phase shown in Figure 7A. Drive shaft 50 has now moved to the inner end of control slot 42 so that the disk 20 has rotated  $15^{\circ}$  opposite to the position it had in Figure 7. This thereby results in a  $30^{\circ}$  oscillation with  $15^{\circ}$  being on each side of the axis of rotation of disk 20.



Figure 10 shows a further phase of operation as cam 32 continues to rotate back toward its original position. In the phase shown in Figures 10 and 10A there has been a  $270^{\circ}$  rotation. Cam track 36 has accordingly rotated  $270^{\circ}$  and drive shaft 50 is sliding back in control slot 42 toward its original position of Figure 7 and 7A.

5 By proper sizing and location of slot 42, pivot 44 and cam track 36, it is possible to control the degree of oscillation of disk 20. Preferably, the degree of oscillation should be  $30^{\circ}$  or less. The invention, however, might also be practiced where the degree of oscillation is in a range of  $15^{\circ}$  to  $40^{\circ}$ .

10 By providing a straight linear control slot the motion of drive shaft 50 is maintained planar. Where the straight linear control slot is parallel or is in the same plane as the outer surface 22 of head 14 carrying the cleaning members 21, the planar movement is also parallel to the outer surface 22. It is to be understood, however, that the invention could be practiced where other shapes and orientations of the control slot are used. Thus, for example, the control slot could be at a non-parallel angle such as  
15 an angle  $90^{\circ}$  to the outer surface 22 which would result in a planar movement that is not parallel to outer surface 22 as long as the control slot is of a straight linear shape. Figure 11 illustrates a variation where the control slot 42A is of arcuate shape which would result in a corresponding upward/downward movement. Such arcuate movement, however, would be a reciprocating movement which would not result in a  
20 cone-like movement. Where a smooth arc is used for slot 42A the corresponding movement is also smooth.

In a preferred practice of the invention cam track 36 is a circular loop. Other shapes, however, may also be used. Figure 12, for example, illustrates a cam track 36A which is somewhat oval or elliptical in shape. This form of cam track would  
25 result in a non-constant speed of movement of drive shaft 50. As illustrated in Figure

12, the elliptical cam track 36A has a minor axis parallel to the outer surface 22 and of a diameter equal to that of circular cam track 36. The major axis of cam track 36A, is perpendicular to outer surface 22. Other forms of cam tracks can also be used.

5 In the preferred practice of the invention the cam track is a closed loop of smooth configuration. The invention, however, may be practiced where some irregular type closed loop is formed.

The location of pivot member 44 controls the torque and angle of oscillation resulting from the movement of drive shaft 50. By moving the pivot position closer to head 14 there would be an increase in torque, but there would also be a reduction in  
10 the angle of oscillation. Conversely, by moving the pivot position further from head 14 there would be a decrease in torque and an increase in the angle of oscillation.

Any suitable motor 26 may be used for rotating cam member 32. An example of a suitable motor is Mabuchi RF-N60CA-2050. Preferably, a motor with sufficient power yet relatively small in size would be used. As a result, it is possible to use a  
15 small diameter housing for handle 12 and small size components within the treating implement, such as toothbrush 10. This could be accomplished to thereby result in an inexpensive toothbrush or other treating implement which is of small size without sacrifice to the efficiency of operation.

In the illustrated practice of the invention wherein the treating implement is a  
20 toothbrush, the movable treating instrument, namely, the disk 20 on head 14 is reciprocated in an arcuate or rotational direction. Such arcuate movement is desirable to provide, for example, enhanced cleaning. Other forms of movement, however, may also be achieved such as a vibratory movement where the treating implement is intended to provide massage benefits.

25 In the illustrated version of the invention wherein there is planar reciprocating

movement, the benefits achieved would be less wear on the various components such as the drive shaft and head as well as less vibration.

As can be appreciated the combination of a control member having a control slot which confines the direction of movement of the drive shaft and wherein the drive end of the drive shaft is freely mounted in a closed loop cam track offset or eccentric with regard to the axis of rotation of the cam member, there results an effective control in the movement of the drive shaft which can be transmitted to a portion of a head in a treating implement to thereby effectively control the movement of the treating elements such as the cleaning elements of a power toothbrush.

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